BIODIVERSITY

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How Human Health Depends on Biodiversity

Eric Chivian and Aaron Bernstein

There is an expression in medicine called "the final common pathway" that refers to the fact that the same clinical presentation can be caused by many different disease states. For example, patients who are withdrawing from alcohol, or those who have taken certain mind-altering drugs, or even those who have had a stroke or a head injury, may all look the same, presenting with an identical set of symptoms that characterize a state of delirium—confusion, agitation, and disorientation.

We use this analogy because "the final common pathway" of all of our multiple assaults on the environment, whether from our increasing carbon dioxide concentrations in the atmosphere or ozone-depleting chemicals into the stratosphere; or our introducing pollutants into soils, fresh water, or the oceans, is the ultimate impact these actions have on living things. Nothing is more important to understand than how these various impacts on other species and on ecosystems affect our health and our lives. And yet, the medical and scientific communities have largely ignored this subject.

Why this is so is a critically important question that we will not attempt to answer here. But one reason seems to be that, despite there being an increased awareness about environmental threats, many, if not most, people still see human beings as separate from the natural world, immune to its alterations. As a result of this separation, they tend to believe that we can degrade forests, wetlands, the oceans, and other habitats, losing countless species in the process, without these changes having any effect on us whatsoever.

It is this disconnect which is at the heart of the global environmental crisis. And it is a very serious problem, for not only are the full human dimensions of biodiversity loss failing to inform policy decisions, but, of even greater concern, the general public, lacking an understanding of the health risks involved, is not grasping the magnitude of the biodiversity crisis and not developing

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a sense of urgency about addressing it. Tragically, ecological, aesthetic, ethical, religious, even economic arguments about the consequences of biodiversity loss have not been enough to convince them.

Sustaining Life

To address this enormous gap in our understanding of the natural world, our Center proposed that it convene an international scientific effort to compile what was known about how biodiversity contributes to human health and to produce a comprehensive report, under the auspices of the United Nations. Three U.N. agencies—the U.N. Environment Programme, the U.N. Development Programme, and the Secretariat of the Convention on Biological Diversity agreed to co-sponsor this project, and they were soon joined by the International Union for the Conservation of Nature (IUCN). The result of this seven year long effort has been the publication of our Oxford University Press book, *Sustaining Life: How Human Health Depends on Biodiversity*, in June of 2008, which Al Gore called "the most complete and powerful argument I have seen for the importance of preserving biodiversity."

We wanted the book to be used as a textbook in colleges, universities, and high schools, and therefore it had to stand on its own and include chapters that explained what biodiversity was and how it was threatened by human activity, and it had to cover the full range of ecosystem services and how they functioned to sustain all life, including human life, on Earth. We wanted the book to become the main reference on the subject for scholars in ecology and medicine, and therefore, it had to review and cite the latest scientific literature so that readers could seek out primary sources (the book contains more than 1400 references).

But mostly we wanted the book to become a key resource for policymakers, environmentalists, and others concerned about what we are doing to the natural world, to provide for them the stories they needed to make strongest argument of all--that we really do not have a choice about whether we protect the natural world or not, that we must do so because our health and our lives depend on it. Therefore, we had to write *Sustaining Life* in everyday language that readers without a scientific background could understand.

We are delighted that we seem to be reaching all three audiences. The book has been adopted as a textbook in courses at Harvard and at the University of Wisconsin, and there is great interest at many other schools. It is being widely used as a key reference by scientists, physicians, and public health professionals. And it has become a major resource for regional, national, and international environmental groups, and for policy-makers at the U.N. and in the U.S. Senate.

While the book has chapters on: medicines derived from plants, animals, and microbes on land and in the oceans; the contributions that a wide variety of species have made to medical research; how biodiversity affects food production on land and in aquatic environments (as well as a chapter on genetically modified foods and organic farming); and how biodiversity loss alters the emergence and spread of human infectious diseases, the heart of the book is the chapter on seven groups of organisms that are among the most threatened on Earth—amphibians, bears, sharks, non-human primates, cone snails, gymnosperms (the group of plants that includes conifers and the Ginkgo Tree), and horseshoe crabs. This chapter details how species in each of these group are threatened by human activity, reviews how they have contributed to the development of important medicines and to new insights in medical research, and points to their potential in helping us treat presently untreatable diseases, if we don't drive them to extinction.

Case Study Examples

1. The first is about polar bears. It is predicted that these magnificent creatures will be extinct in the wild by the end of this century, largely because of melting Arctic sea ice secondary to global warming. Polar bears have become iconic figures in discussions about global warming, but their medical value is rarely mentioned.

Like all bears that den (it is called "denning" as bears don't go into the very depressed metabolic state and deep stupor that hibernating animals like woodchucks do), polar bears are essentially immobile for 5-7 months or more, and yet they don't develop osteoporosis, which every other mammal, including humans, gets during periods of immobility. We would lose a third or more of our bone mass during this period. Osteoporosis is a huge public health problem, resulting in more than 70,000 deaths each year in the U.S. alone. Denning bears have compounds in their blood streams that may someday allow us to effectively prevent and treat this largely untreatable disease.

Bears also don't urinate for the months they are denning and yet don't become toxic. If we don't urinate for a few days, we die. No-one fully understands how bears are able to recycle their urinary wastes and break them down and make new proteins, but denning bears may hold the secret for our being able to cure this devastating medical problem, for which there is no present treatment other than dialysis or kidney transplantation, and which kills more than 80,000 Americans a year, costing the U.S. economy more than $27 billion annually.

Polar bears become massively obese on seal blubber prior to denning, but they don't develop diabetes Type II, as we tend to do when we become obese. Why they don't become diabetic is also not well understood. Obesity-related diabetes Type II is essentially epidemic in the U.S., afflicting more than 16 million Americans, some 5 percent of the population.

If we lose polar bears in the wild, we may never find out why they don't develop osteoporosis, get toxic from urinary wastes, or become diabetic.

2. Cone snails are a large group of predatory snails that live mostly in tropical coral reefs. They defend themselves and paralyze their prey for food—worms, small fish, and other mollusks---by firing a poison-coated harpoon at them. Each of the 700 cone snail species is thought to make 100-200 distinct poisons, so there may be as many as 140,000 different cone snail poisons in all. These poisons are extremely potent and specific in their action, and they attach themselves to an enormous number of different molecular sites on human cell membranes that regulate how our cells function.

One of these toxins has led to the development of a pain-killer called Ziconotide now on the market. Ziconotide is 1000 times more potent than morphine in relieving pain, but of far greater importance, unlike morphine, it doesn't lead to tolerance. The development of tolerance has limited the effectiveness of opiates like morphine in treating severe, chronic pain, as the medication in many cases becomes less and less effective over time, requiring higher and higher doses.

The discovery of a powerful pain-killer that doesn't lead to tolerance, found after examining only six cone snail species and only 100 cone snail toxins in any detail, is a watershed event in medicine. Cone snails may contain the largest number of important new pharmaceuticals for human use of any group of organisms in Nature. Yet they live in coral reefs, which are increasingly threatened worldwide, mostly by oceans heated by global warming.

3. Finally, let us tell the story of gastric brooding frogs. The female frog swallows fertilized eggs, which then hatch in her stomach. There they develop into tadpoles, and when they reach a certain stage of development, their mother vomits them into the outside world where they continue their development into adulthood.

All vertebrates, including amphibians, produce substances that regulate the release of acid and enzymes to begin the digestion of food in their stomachs. Not surprisingly, it was discovered that the newly hatched gastric brooding tadpoles secreted a substance, or substances, that inhibited the digestive process and that may have led to new insights for preventing and treating human peptic ulcer disease, a disease that afflicts more than 25 million people in the U.S. alone.

But the studies that were underway to characterize these compounds and how they worked could not be continued, because both species of gastric brooding frogs, the only ones ever discovered on Earth, went extinct. And the miraculous chemicals that evolved in these frogs, perhaps over millions of years, chemicals that could have provided more effective peptic ulcer treatments are now gone forever!

We wish to end this essay by quoting the last paragraph of our Preface and our Dedication, as they will say more concisely what we would like to say in conclusion.

From the Preface

Scientists with expertise in a wide range of disciplines, from industrialized and developing countries alike, have been involved in putting this book together. We have done so because we are convinced that it can help people understand that human beings are an integral part of Nature, and that our health depends ultimately on the health of its species and on the natural functioning of its ecosystems. We have done so because all of us hope that our efforts will help guide policy makers in developing innovative and equitable policies based on sound science that will effectively preserve biodiversity and promote human health for generations to come. And we have done so, finally, because we all believe that life on Earth is sacred and that we must never give up in trying to preserve it, and because we all share the conviction that once people recognize how much is at stake with their health and lives, and with the health and lives of their children, they will do everything in their power to protect the global environment.

And finally from the Dedication

We dedicate this book to the millions of plant, animal, and microbial species we share this small planet with, and to our own species, Homo sapiens, who first walked on Earth some 195,000 years ago, and struggled to survive over the millennia to become the magnificent and extraordinarily powerful beings we are today.

May we have the wisdom, and the love for our children and all children to come, to use that power to save the indescribably beautiful and precious gift we have been given.

Sustaining Life: How Human Health Depends on Biodiversity is published by Oxford University Press. Edward O. Wilson has written the Foreword and Kofi Annan the Prologue. It has over 200 four-color illustrations. List price $34.95.

President's Message

To Value Nature

Steve Whitney, *Bullitt Foundation*

"The cynic knows the price of everything and the value of nothing." - Oscar Wilde

The local Seattle papers recently profiled work to place a dollar value on the entirety of the Puget Sound. The very idea seems a bit preposterous and the reported range of value -- between $7 billion and $62 billion – doesn't make it easy to take the study seriously. The lead author was quoted as understating the obvious, "This is an imperfect study, but it's better than giving it a zero."

I suppose so. But to me this kind of effort to monetize the value of a complex natural ecosystem is a bit like valuing a human life by tallying up the dollar value of the body's component parts. It is possible to come up with a number, but doing so has little meaning or utility, and very likely will undervalue the whole.

Even so, and despite real limitations on our ability to accurately value nature or predict the future, ecosystem valuation is increasingly used as a conservation decision tool. It is said that in order to make rational choices among alternative uses of a given natural environment, it is important to know both what ecosystem services are provided by that environment, and what those services are worth. Fair enough - but not easily done.

It is evident that we can put a dollar value on some, readily identifiable ecosystem services and that this information could assist in a cost/benefit analysis of alternative land management schemes. But the question is, should we? My great fear is that in our zeal to apply this new tool, we may be jumping to the valuation step before we have a clear and complete understanding of the system we purport to be evaluating.

But there is more. An emerging area of environmental policy pertains to payments for ecosystem services (PES). The concept is relatively simple: those who "provide" environmental services by conserving or restoring natural ecosystems should be compensated by the beneficiaries or users of the services.

Perhaps the best-known U.S. example is the effort of New York City to protect the quality of its Catskill Mountains drinking water supply. The 1989 Safe Drinking Water Act mandates filtration of public surface water supplies, but offers a waiver opportunity for those water suppliers able to demonstrate alternative ways to meet water quality standards. In order to avoid a significant investment in filtration plant construction and associated operating costs, New York City is achieving the same end by investing much less in maintaining the health and integrity of its watersheds and the natural water filtering services they provide.

Internationally, similar examples are to be found.

- In Costa Rica, public funding derived primarily from a tax on fuel sales compensates landowners for efforts to conserve and restore forests.
- In France, Perrier Vittel compensates upstream landowners to follow prescribed land management techniques and use low intensity dairy farming practices in order to protect the quality of supply for its bottled water enterprise.

- In Honduras, a watershed-based PES program protects the water supply of 1000 families in the municipality of Copan Ruinas from the adverse impacts of commercial logging, application of agrochemicals, and other intensive agricultural practices.
- In the Murray-Darling Basin in southwestern Australia, widespread land clearing causes salinization of soils and irrigation water in many areas. In response, the 600 affected farm operators each purchase farm acreage-based salinity credits from the state forestry department. The proceeds of salinity credit sales are then invested by the state in large-scale revegetation efforts in key watershed areas.

These and many other examples (the International Institute for Environment and Development claims there are nearly 300 operating models worldwide) have caused academics and policy makers to grapple with important questions about how payment systems can best be structured, value calculated, compliance monitored, and durability ensured. They also have begun to think not just about what is required to achieve authentic and verifiable long-term benefits from ecosystem valuation and PES schemes, but also what tools are needed to bring the ideas to scale.

One area receiving particular scrutiny is the emerging market for forest carbon credits. Forests play a significant role in both stabilizing and destabilizing the climate through mechanisms of carbon dioxide (CO2) absorption and sequestration during forest growth, and CO2 release through forest loss. Indeed, a reduction in native forest cover is a double loss in the fight against global warming: the forest's ongoing absorption of CO2 ceases and its stored carbon is added to the atmosphere.

Here in the west, institutional mechanisms are now under development to facilitate payments to landowners in return for managing forests for carbon capture and sequestration. This is a tricky business, especially if forests (a biological carbon sink) are conserved as mitigation for combustion of coal or oil (a geologic carbon source). No matter how well a PES agreement for forest conservation may be structured, such biological sequestration is inherently temporary – certainly so in a geologic time frame.

Therefore, a key question for policy-makers is whether forest carbon offsets should be allowed as mitigation for the release of geologic carbon at all, and if so, how such policies can be structured to avoid the uncertainties associated with biological carbon sequestration. In general, these uncertainties are associated with permanence, leakage, and additionality.

Permanence pertains to the length of the carbon sequestration commitment and the likelihood that contractual obligations can be assured over the life of the agreement. Commonly such agreements are set at 100 years, but assurance of compliance is difficult to guarantee over such a long timeframe with unproven monitoring regimes and a high likelihood of land title changes. As a consequence, a preference is now emerging for incorporation of carbon agreement pro-

visions into legally binding conservation easements that flow with the property notwithstanding ownership.

Leakage occurs when emissions avoided within a particular site are not eliminated but rather shifted to another location, e.g. when sequestration at a site leads to land clearing elsewhere. I would extend the definition of leakage to include the likely incremental loss of carbon stores on any forested area over an extended timeframe due to fire, windthrow, forest pests, and debris flows – all events made more likely by climate change.

Historically, these risks have been managed by requiring purchase of forest carbon offsets on a greater than 1:1 ratio to provide a bit of insurance that some leakage can be accommodated without destroying the integrity of the agreement. More recently, conservation forestry advocates have argued against agreements reliant on a single forest property, and instead advocate a sectoral view whereby the entire forest sector in a defined geography is aggregated, and carbon accretion and leakage is accounted for on that basis. Such an approach can ensure that the forest sector as a whole is managed for net carbon benefits before any forest carbon credits are made available in the marketplace.

And finally, additionality pertains to the measurement of the actual supplemental carbon sequestration reasonably attributable to the forest conservation agreement – e.g. above and beyond what would be expected in the absence of the agreement. This is important to get right because landowners should not be offered compensation for measures required to comply with basic laws and regulations established to protect the public's health, safety, and welfare – including environmental protection.

One potential method for assuring additionality is to tie the availability of a forest carbon credit to a decision on the part of the landowner to adopt Forest Stewardship Council (FSC) certified management. FSC's peer-reviewed requirements, rigorous certification standards, and regular audit process can guarantee that forest practices remain sustainable and well above the requirements of basic forest practices rules, that forest carbon sequestered is additional to that which could be otherwise expected, and that any deviations from the agreement are detected in a timely manner. Such a mechanism also would create a clear financial incentive for landowners to adopt FSC standards.

The art and science of nature valuation is evolving rapidly, and because many innovations in the field are being tried in an international context it is an area of environmental policy that can be difficult to monitor. Nonetheless, ecosystem valuation and market-based mechanisms are likely to become ever more common in the coming years and we need to pay attention to them. The CGBD has an important role to play in helping us effectively monitor developments in the field.

CGBD WORKING GROUPS

Climate and Energy Funders Working Group

The Climate and Energy Funders Group, along with other CGBD colleagues, held a number of events and convenings at the Environmental Grantmakers Association 2008 Annual Retreat. The Climate and Energy Funders group convened two ad hoc sessions: *The Road to Copenhagen,* addressing the outlines and issues around the international climate negotiations; and *Moving and Messaging a Clean Energy Agenda*. The group also held a working lunch with community foundations to discuss supporting efforts to inject local concerns and leadership into the federal policy debate.

The CGBD will be leading a funder delegation to COP 14 in Poznan, Poland, December 9-14, the final week of the next international climate negotiation. Funders will meet with government delegates, NGO representatives, and European philanthropists. The group is planning a one-day strategy session with European and US NGOs and funders on Saturday, December 14. Plans have already begun to attend COP15, to be held in Copenhagen.

On November 13, the Climate and Energy Funders hosted a conference call on potential impact of state and federal elections on climate and clean energy policy.

Marine Conservation

Meghan Calcari of the Gordon & Betty Moore Foundation has been named Co-Chair of the Marine Conservation Working Group. Meghan is a long-time member of the group and has participated in planning several of the group's annual meetings. High on the group's "to do list" is to re-establish their regularly scheduled conference calls.

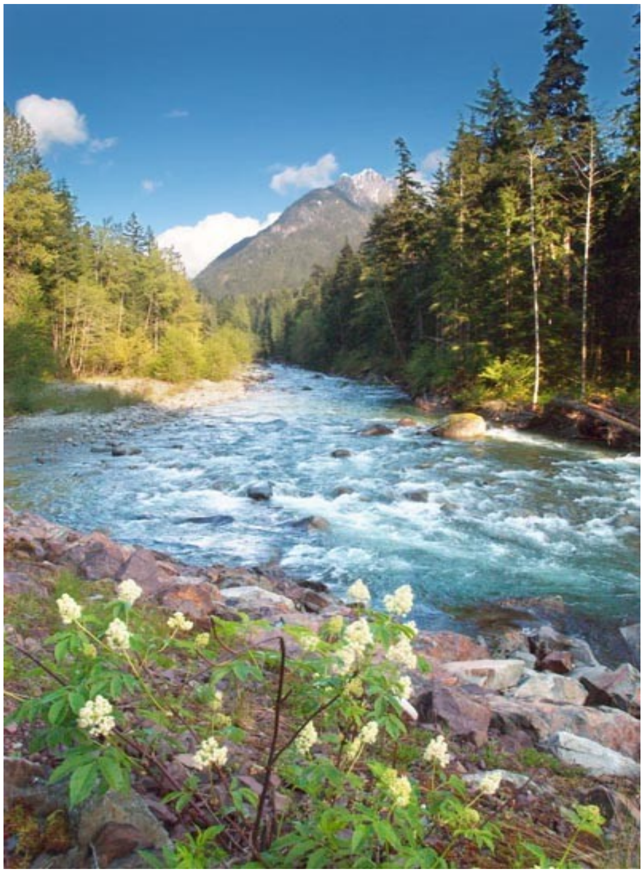
Toward the end of the year, the Working Group will once again administer its annual member survey looking at the program mission, strategic focus, subject area emphasis, and geographic focus of its members. Meaghan and Bill Hull will be working with interested members to improve the survey design to assure that it meets members' needs.

Finally, the Working Group will soon begin planning for its annual meeting, which typically occurs in late winter or early spring.

Land & Freshwater Conservation

Over the past few months, conservative funders, industry groups and the Administration have waged a well-funded, disciplined campaign to open new areas in the US, both onshore and offshore, to oil and gas development. Dubbed "Drill Here, Drill Now, Pay Less," the goal of the campaign is to convince the public that high gasoline prices are the direct result of insufficient domestic production and that prices will go down if we simply authorize drilling areas currently off limits to energy development. In response to these actions, on August 11 the Working Group hosted a well-attended conference call for funders to discuss the nature of the threats and how to respond in the short-, medium- and long-term.

On September 10, the Working Group also sponsored a conference-call briefing on threats to the federal Endangered Species Act. Recently the Department of Interior proposed a series of major revisions to the



Endangered Species Act (ESA). When combined these changes represent the most significant rewriting of the ESA in 22 years.

The proposed changes are regulatory in nature, and, as such, would not have to be approved by Congress. They would have three overlapping impacts: (1) they would allow federal agencies to decide if their actions would harm an endangered species without any consultation with the Fish and Wildlife Service or National Marine Fisheries Service, which are currently responsible for protecting endangered species; (2) they would prohibit consideration of the impacts of global warming on wildlife, disregarding, for example, the report of the Intergovernmental Panel on Climate Change which says global warming threatens up to one-third of species with extinction; and, (3) they would redefine what should be considered as the "current range" for a species, greatly reducing the amount of acreage that should be considered as part of a critical habitat for a species.

Finally, on October 14 the Working Group hosted conference call on the US Forest Service's Roadless Area Conservation Rule. In January 2001, a multi-year effort of a diverse coalition of conservation and citizen groups the protection of 58.6 million acres, or nearly one-third of the 192 million acres of national forest land, through the U.S. Forest Service's Roadless Area Conservation Rule (RACR). Nearly eight tumultuous years later, the rule has proven largely resilient to challenges from multiple lawsuits, agency maneuvers to reduce its safeguards and even a formal repeal. In the coming year, changes in executive branch leadership offer a new opportunity to put the RACR on firmer footing by persuading the new president to make protection of our national forests an environmental priority and embrace the RACR as the law of the land.

Conservation Science

On October 21-23, the CGBD convened a meeting for funders to examine and discuss the challenges and opportunities presented by a changing climate. Although the meeting was designed to attract participation by representatives of all the CGBD Working Groups, several members of the Conservation Science Working Group are taking a particularly active role in planning the meeting agenda.

Building upon the momentum generated at this year's CGBD Annual Meeting in Tucson, this meeting brought together funders with some of the leading scientists and strategists dealing with climate change adaptation issues. Agenda topics included:

- Forecasting Climate Impacts on Natural Systems, Resources, and People
- Informational Resources and Tools
- Addressing the Climate Adaptation Challenge

Health & Environmental Funders Network (HEFN)

HEFN is busy in preparation for its December meetings at the Institute at the Golden Gate in Sausalito, California. On December 9-10, HEFN will host a national retreat for funders interested in strategic collaboration on health and environment. The retreat is being designed to help funders learn from each other, share insights and strategies, and advance collaboration in and across funder interests.

On December 11-12, HEFN-California will host its third annual convening for funders supporting environmental health and environmental justice work in California. HEFN has contracted with systems thinking expert Scott Spann to work with participants at both December meetings on strengthening our shared vision of what is possible, our strategic analysis of what is necessary, and our collaborative capacity to make an even greater collective impact.

HEFN's Women's Environmental Health Work Group has worked with the Funders Network on Population, Reproductive Health and Rights to develop a session on "Joined in Justice: Environmental Challenges, Reproductive Impacts" for the Funders Network's upcoming annual meeting, November 13-14, in Santa Cruz, California.

HEFN continued its monthly funder conference call series throughout the fall, highlighting cutting edge issues like: a scoping focused on green chemistry and sustainable agriculture, the first federal ban on phthalates in toys, and strategies to reform federal chemical policy.

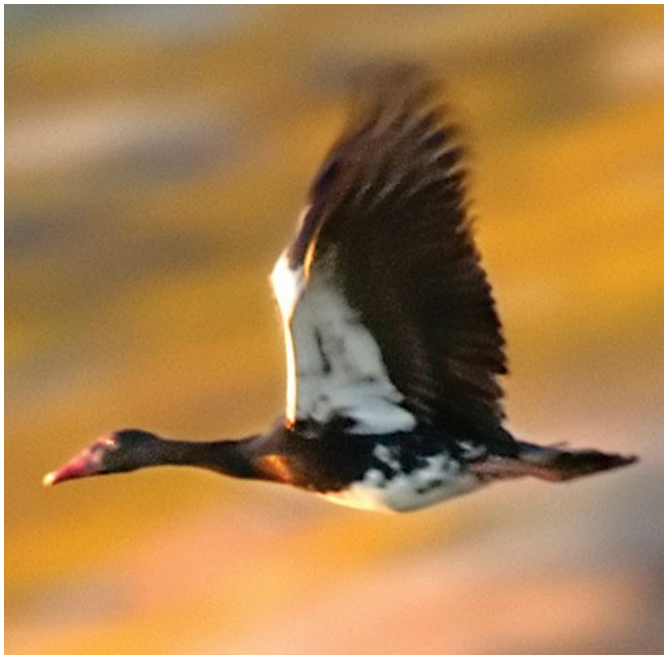
The conference call series continued with a November 12 call focused on a recent report, "Environmental Threats to Healthy Aging." This call, co-sponsored by Grantmakers In Aging, Grantmakers In Health, and the Funders' Network for Smart Growth and Livable Communities, will feature two report authors: Ted Schettler, MD, MPH, and Jill Stein, MD.

Gulf of California

The Gulf of California (GOC) funders participated in a CGBD-coordinated visit to Bahia de los Angeles on the Baja California peninsula in mid-October to learn about local land conservation projects and easements, the new biosphere reserve, and marine conservation work.

In September, Marina Cazorla attended a NOAA-sponsored symposium on the endangered vaquita porpoise, which was named the world's most endangered cetacean by IUCN during its World Congress in Barcelona in October. Marina will attend an upcoming event in Puerto Penasco at which the North American Conservation and Recovery Plan for vaquita will be released, followed by a technical experts meeting.

Marina continues to work with and coordinate among funders on vaquita conservation.



Member News

As Manager of the Coastal Program, **Liz Crosson** oversees **Environment Now's** programs to eliminate pollution and prevent degradation of California and Baja California's coastal ecosystems. Coastal Program staff and allies enforce existing environmental laws and launch new initiatives to achieve these goals through grassroots advocacy and litigation.

Liz gained environmental litigation experience working with the Pacific Environmental Advocacy Center in Portland, Oregon where she assisted on statewide water and air quality issues. Liz also gained advocacy and organizing skills as a law clerk with the Oregon Chapter of the Surfrider Foundation working with a range of diverse stakeholders on wave energy proposals and coastal water quality issues.

Liz holds a J.D. from Lewis and Clark Law School and a Masters of Science in Environmental Education from Southern Oregon University. While at Lewis and Clark, Liz was a member of the 2008 Environmental Moot Court First Place team at Pace University and was recently named the recipient of the Environmental Alumni Association's Williamson Award for her dedication and achievement in public interest environmental law.

The Oak Foundation has announced the appointment of **Kathleen Cravero-Kristoffersson** as its new President, effective February 1. Kathleen has been the Director of the Bureau of Crisis Prevention and Recovery of the United Nations Development Programme (UNDP) since March 2005. In that capacity she leads the efforts of UNDP around the world to restore the quality of life for people who have been devastated by natural disaster or violent conflict.

Kathleen has over two decades of experience in international development, including with UNICEF, WHO and UNDP. She has first-hand knowledge of a range of development issues, including child protection, ensuring womens full involvement in the social and economic life of their countries, human rights and good governance.

Kathleen has a doctorate in Political Science (Fordham University) and a Masters in Public Health (Columbia University).

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